-continued

Z_{LR}	Distance along z axis between lens and retina
Ω_{OD}	Solid angle formed between point source and δA_D
Ω_{DL}	Solid angle formed between the intersection of the ray we are following and the diffuser plane
M	Magnification of the lens system
$\| \ \|$	Modulus of a vector
$\|\| \ \|\|$	Norm of a vector
$\rightarrow$	Direction of optic flow
ω_i	$\|R * _{OD}\|$
ω_o	$\|R * _{DL}\|$

[0037] This analysis enables one to take a spatial filter of a particular type, spaced at a particular distance from the display and to derive a linear transform to be used on a representation of the image. So the presence of the physical apparatus is not required to evaluate the correct BTDF, or portion thereof, and distance to provide the optimum image quality, saving development time and cost.

[0038] Images that are portrayed and viewed using typical display technology are discreet approximations of the real world and are said to be pixelised. The diffusion of said pixelisation, so that the sharp boundaries between pixels are no longer perceptible, is one method to make the object appear more natural. Prior art diffusion and de-pixelisation methods are subject to trial and error. Upon the application of a diffuser, or other spatial filter to an image the luminance as measured substantially in the direction perpendicular to the surface of the image layer, the viewer looking substantially in this direction when viewing or using the display, will be reduced and consequently the contrast will be reduced. Additionally if there are any interstitial elements between the image layer and the diffuser then it may not be possible to get the diffuser close enough to the image layer so as not to over blur the image. Prior art provides no way to finely control said depixelisation nor is there a way to predict for a given spatial filter at a given distance what the effect on the image will be in terms of contrast, luminance, point spread and most importantly the viewers perception of the image. The current invention describes a way to pre-determine, control and most importantly optimize the de-pixelisation process.

[0039] The preferred point spread function should remove frequencies higher than the sub-pixel frequency, but none below. The ideal filter would be a perfect cut-off filter at the sub-pixel frequency. However given a range of physically realisable filters with known BTDF's a difference metric, such as differences between the square root integral, weighted by the contrast sensitivity function of the human visual system, can be used to determine the departure from the ideal, which can be minimised, so as to pick the best physical embodiment.

[0040] According to another aspect of this invention it is desirable to maintain as far as practical the contrast and luminance characteristics of the original object. Also it is preferable, because of the presence of interstitial optical films of significant thickness, to be able to have the spatial filter as far from the image as possible. This is achieved when the bi-directional transmission distribution function is narrow for all input angles.

[0041] According to another aspect of the present invention point spread function can be pre-determined and the trade off between moiré interference and image clarity abated;

[0042] in an optical system consisting of at least two addressable object planes with periodicity and at least one spatial filter between at least two of the addressable object planes where said point spread function is a result of the application of spatial filter(s) on said image,

[0043] with said point spread function being controlled by varying the distance between an object and said spatial filter(s) and varying bidirectional scattering transmission function characteristic of the spatial filter(s).

[0044] In typical multilayered technologies moiré interference is caused due to the periodicity of the layers. Diffusion techniques can be employed to abate moiré interference. However methods employed in prior art are subject to trial and error and result in residual moiré interference and an unnecessarily large drop in the perceived quality of the image.

[0045] The moiré interference as it appears on the image plane can be characterised by the following equation which describes the luminous intensity of the final image evaluated at the retina or any other image plane

$$E(x,y) = \frac{\sum_{\substack{i=1\ldots m\\ j=1\ldots n}}^{m,n} BL_0 \cdot \left(PSF(x,y) * \begin{bmatrix} R(x,y)_R T(\lambda)_{Red,R} \\ R(x,y)_G T(\lambda)_{G,R} \\ R(x,y)_B T(\lambda)_{B,R} \end{bmatrix} \right) [F(x,y)_R T(\lambda)_{Red,F}\, F(x,y)_G T(\lambda)_{G,F}\, F(x,y)_B T(\lambda)_{B,F}] M^2 A_{lens} \cos^4(\theta)}{z'^2} \tag{2}$$

[0046] Where BL_0 is the radiance of the backlight, PSF(x, y) is the point spread function described earlier, T_{Red}, T_G and T_B are the spectral transmission functions of the dye layers where second subscripts R and F designate the front and rear imaging layers respectively, M is the magnification of the thin lens system given by z'/z_o and A_{lens} is the area of the lens in the system.

[0047] Once the intensity distribution on the back of the retina is known the distortion to the subjective image quality is described by the following metric

$$D_1 = \frac{1}{\ln(2)}\int_{v_o}^{v_{max}} \sqrt{\frac{M_{D_o(v)}}{M_t(v)}}\, d(\ln(v)) - \frac{1}{\ln(2)}\int_{v_o}^{v_{max}} \sqrt{\frac{M_D(v)}{M_t(v)}}\, d(\ln(v)) \tag{3}$$

$$D_2 = \frac{1}{\ln(2)}\int_{v_o}^{v_{max}} \sqrt{\frac{M_{M_o(v)}}{M_t(v)}}\, d(\ln(v)) - \frac{1}{\ln(2)}\int_{v_o}^{v_{max}} \sqrt{\frac{M_M(v)}{M_t(v)}}\, d(\ln(v))$$

$$D = D_1 + D_2$$